International Journal of Agriculture, Environment and Bioresearch

Vol. 2, No. 02; 2017

ISSN: 2456-8643

AN ASSESSMENT OF NOISE LEVEL AND ASSOCIATED HEALTH EFFECTS IN STONE CUTTING INDUSTRIES AT SARDIKHOLA VDC, KASKI, NEPAL

Bhawani Prasad Pandey
Corresponding Author
E-mail: bhawanipdpandey@gmail.com

College of Applied Sciences-Nepal, Kathmadu
(Affiliated to Tribhuvan University)

ABSTRACT

A study was carried out at Sardikhola VDC of Kaski district to assess the noise levels produced from stone cutting industries during their activity cycle and to predict the risk of environmental noise induced health effects to the workers and neighbours to the industries. Noise levels were measured by using a digital sound level meter (Lutron SL - 4010) in twelve industries (5 with single machines and 7 with double machines) during their activity cycle for three times a day for three days. Altogether, 35 questionnaires were subjected to the exposed group and 15 to the non-exposed group. The observed noise levels in all industries exceeded the allowed limit value of 85 dB(A) as recommended by WHO. The observed maximum and minimum noise levels for selected single machine industries for average equivalent sound pressure level (LAeq), nominal 8-hour noise exposure level (LAeq,8hr) and weekly average of the daily noise values (LEP,W) were 110 dB(A), 108 dB(A) and 105 dB(A); and 104 dB(A), 104 dB(A) and 101 dB(A) respectively. Similarly, for the double machine industries it was 108 dB(A), 106 dB(A) and 103 dB(A); and 103 dB(A), 102 dB(A) and 99 dB(A) respectively. The major health effects induced by environmental noise were found to be tinnitus followed by speech interference, hypertension, irritation, loss of sexual potency, difficulty to concentrate and blood pressure rise. The crude OR and 95% Cl for the exposed subject were 6.42 (0.75, 55.12).

Keywords: Nepal, Stone Cutting Industries, Noise Level, WHO, Health Hazards and Odds Ratio.

Introduction

Noise is an inevitable by-product of modern urbanisation and industrial development. Indeed, environmental noise pollution is not an entirely new phenomenon, but rather it is a problem that has grown steadily worse with time [1]. Noise can be defined as any unwanted sound or sound that is loud, unpleasant, unexpected, disturbing and harmful that impair or interferes with hearing, causing stress, hampers on concentration and work efficiency or cause accidents [2,3].

Vol. 2, No. 02; 2017

ISSN: 2456-8643

World Health Organization [4] has categorised adverse health effects of noise pollution on humans into seven categories: hearing impairment, interference with spoken communication, sleep disturbances, cardiovascular disturbances, and disturbances in mental health, impaired task performance and negative social behaviour and annoyance reactions.

Few researches have been conducted to measure the noise level produced by various machines and processes in different industries within Kathmandu and outside. High noise levels were observed in textiles industries, metal works, cement industries and flourmills [5, 6]. The main purpose of this study were to measure the noise levels produced by stone cutting industries during their activity cycle and to find out noise induced health effects on workers. This research reports the noise levels in stone cutting industries outside the capital city for the first time.

Materials and methods

Study Area

The study was carried out in the industries at Sardikhola VDC of Kaski district, Nepal; lies in a sub-tropical climatic zone and situated at 28°19'N and 083°57'E with 1180 meters above sea level, containing built up area and cultivated land. The total population of the study area was 1,723 (822 male and 901 female) with 437 households [7]. The sound produced by stone cutting from the industries, electric motors, boulder hammering, manual splitting etc. are the major source of noise pollution.

Methods

A case control study and environmental noise pollution survey was designed. Depending on the exposure to environmental noise, two groups namely exposed and non-exposed were categorized. Exposed group were those working in the stone cutting industries (i.e. workers) where sound pressure level exceeded 70 dB(A) and non-exposed group were those who lived or used to perform their activities away from noisy area where sound pressure level did not exceeds 55 dB(A). For the environmental noise pollution survey, a questionnaire was setup in both English and Nepali languages. The sample size was calculated by using the statistical formula given by Arkin and Colton [8] and was found to be 35 for the exposed group. Altogether, 50 questionnaires (35 exposed and 15 non-exposed) were administered for the study. Non-exposed respondents were randomly selected from the nearby residential area and the survey was conducted directly through household visit. The study subjects were interviewed using a structured questionnaire format. Information about their education, occupation, present and past medical history was obtained.

Likewise, a total of 14 sampling points were randomly selected for the noise level monitoring by using noise level meter (Lutron SL - 4010) on the basis of machinery and process in the stone cutting industry i.e. double machine (7 nos), single machine (5 nos), manual splitting (1 nos) and

Vol. 2, No. 02; 2017

ISSN: 2456-8643

boulder hammering (1 nos). Furthermore, the noise levels were also monitored at three consecutive distances (50 m, 100 m and 300 m from the stone cutting industry nearest to the settlement) from two sites to analyze the distance attenuation characteristics. The noise measurement was carried for three days and eight hour weighted basis**.** Odds ratio (OR) and their 95% confidence interval (95% CI) for noise induced health effects were estimated.

Results

Environmental Noise Pollution Survey

Altogether 50 samples covering different environmental settings were surveyed. During survey, the entire respondents had shown familiarity in relation to noise pollution. The major health effects induced by noise pollution were observed as tinnitus followed by speech interference, hypertension, irritation, loss of sexual potency, difficult to concentrate and blood pressure rise. Nausea and aural pain were the least frequently observed health effects (Table 1).

Table 1: Respondents weighed complaints on noise induced health effects

Health Effects	Odds Ratio (95% CI)
Tinnitus (Ringing or Buzzing in the ears)	0.96 (0.27,3.45)
Nausea	1.81 (0.18,17.67)
Dizziness	1.42 (0.42,4.83)
Aural Pain	0.33 (0.08,1.39)
Headache	0.23 (0.06,0.83)
Hypertension	2.0 (0.58, .85)
Speech Interference	0.21 (0.05,0.88)
Irritation	0.27 (0.07,1.03)
Difficult to concentrate	0.24 (0.06,0.92)
Loss of sleep (Insomnia)	1.59 (0.47,5.42)
Nervousness	1.63 (0.43,6.17)
Psychiatric problems	6.42 (0.75,55.12)
Argumentativeness	0.22 (0.06,0.81)
Blood pressure rise	1.21 (0.36,4.07)
Loss of sexual potency	3.0 (0.84,10.67)
Sleep disturbance	1.26 (0.37,4.32)

Noise Related Stresses

In reference to noise induced stress parameters [L_{Aeq}: 106 dB(A), 107 dB(A); $L_{Aeq,8hr}$: 104 dB(A), 106 dB(A)], about 83% were believed that health effects caused by noise from the stone cutting industry. Among them, about 80% had high respiration rate (>20/min); 31.4% had high

Vol. 2, No. 02; 2017

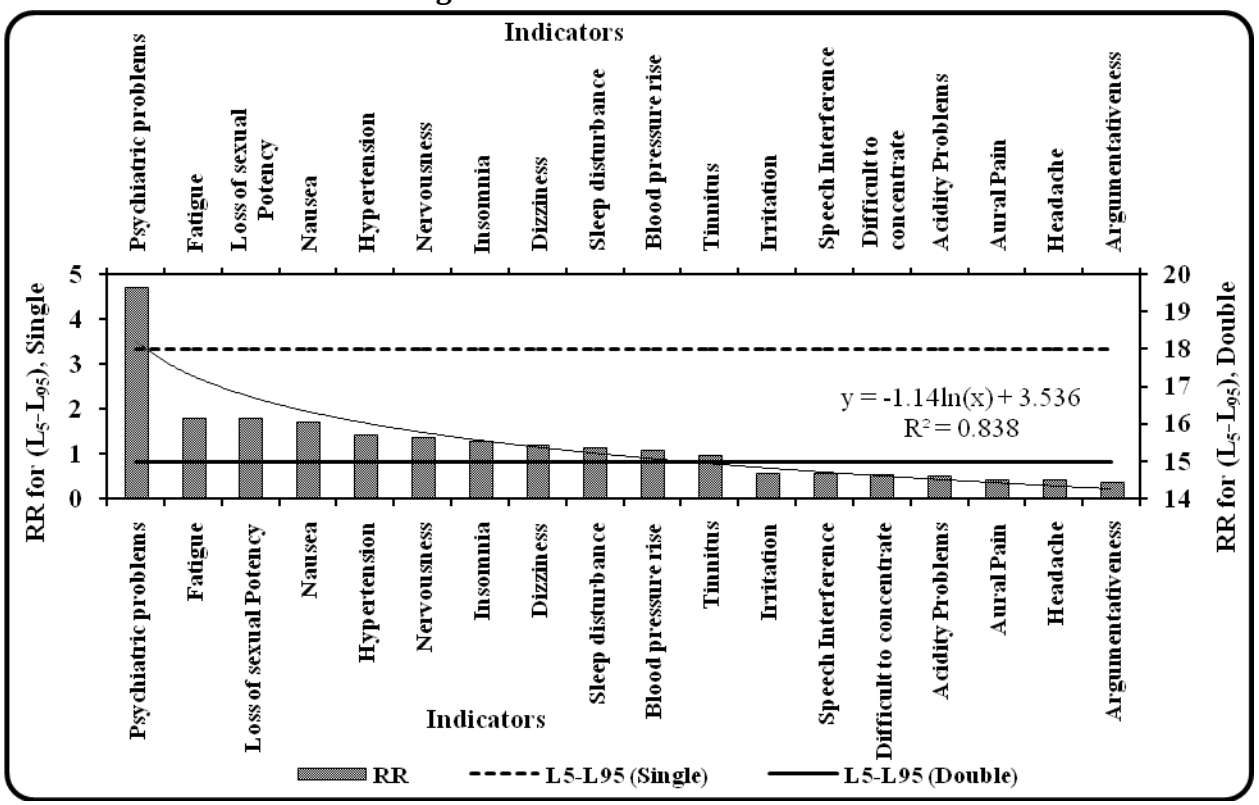
ISSN: 2456-8643

pulse rate (>80/min) and high blood pressure (31.4%) and only 2.9% were suffering from heart disease.

All of the workers were suffering from any kinds of eye impairments (mostly grittiness, 97.1%) and respiratory problems (mostly coughing, 91.4%). The normal infection or injuries in the ears of the workers were increased by 5.7% during their working period and hearing disability with gradual change in hearing threshold was found in 42.9% of them. Due to the mechanical vibration all the workers had problems with hands (mostly wrist pain, 97.1%) and due to continuous working in the industries all of them had problems with their body pain (mostly back pain, 97.1%). The regression analysis entailed that the noise induced stress reactions in the exposed population showed the positive logarithmic response with the difference between L_5 and L_{95} ($R^2 = 0.8381$, Figure 1).

Some of the noise induced stress reactions in non exposed respondent were found higher than exposed population due to the human perception rather than the perceived noise indicators where background sound pressure [60 dB(A)] and daily exposure levels [71 dB(A)] were significantly lower.

Figure 1: Noise Stress Reactions



Vol. 2, No. 02; 2017

ISSN: 2456-8643

Case Control Study

Altogether 50 samples were included in the study. Among them, 35 respondents were directly exposed to noise (i.e. cases) and 15 respondents were not exposed to noise (i.e. controls). There were altogether 96% males and 4% females. The age of the respondents ranged from 18 to 57 years and only 17% were smokers. Variables like sex ratio, education status, occupation, medical history, history of smoking and alcohol consumption were not significantly different between the cases and controls.

Among the exposed group, there were a significant excess risk of psychiatric problems, loss of sexual potency and hypertension due to the exposure of environmental noise. The crude OR (95% CI) for the psychiatric problems, loss of sexual potency and hypertension within the exposed subjects were 6.42 (0.75, 55.12), 3.0 (0.84, 10.67) and 2.0 (0.58, 6.85) respectively.

Noise Levels

Noise levels were measured from the selected different single and double machine industries. Average equivalent sound pressure level (L_{Aeq}), nominal 8-hour noise exposure level ($L_{Aeq,8hr}$) and weekly average of the daily noise values ($L_{EP,W}$) of the different stone cutting industries are shown in Table 2. Maximum and minimum L_{Aeq}, $L_{Aeq,8hr}$ and $L_{EP,W}$ were measured 110 dB(A), 108 dB(A) and 105 dB(A); and 104 dB(A), 104 dB(A) and 101 dB(A) respectively from the single machine industries. Similarly, from the double machine industries the measured maximum and minimum descriptors values were 108 dB(A), 106 dB(A) and 103 dB(A); and 103 dB(A), 102 dB(A) and 99 dB(A) respectively.

Table 2: Average noise descriptor values from different reference points

Reference Points	**Noise Descriptors**		
	Average Values, dB(A)		
	L_{Aeq}	$L_{Aeq, 8hr}$	**$L_{EP,W}$**
Single Source			
SC 07	104	104	101
SC 20	106	105	103
SC 30	110	108	105
SC 34	106	106	103
SC 42	108	107	104
Average	**107**	**106**	**103**
Dual Sources			

Vol. 2, No. 02; 2017

ISSN: 2456-8643

Reference Points	Noise Descriptors		
	Average Values, dB(A)		
	L_{Aeq}	$L_{Aeq, 8hr}$	$L_{EP,W}$
SC 05 / 06	103	102	99
SC 12 / 13	106	104	101
SC 16 / 17	105	103	101
SC 18 / 19	104	102	99
SC 25 / 26	106	104	102
SC 27 / 28	108	106	103
SC 47 / 48	107	106	103
Average	**106**	**104**	**101**

The major noise emitting activities are continuous stone cutting, boulder hammering and manual fracturing. Activity wise weekly average nominal 8 hour noise exposure level ($L_{Aeq,8hr}$) for boulder hammering and manual fracturing were 92 dB(A) and 99 dB(A) respectively; average maximum sound pressure level were 103 dB(A) and 111 dB(A) respectively. The measured values of background noise level (L_{95}), average noise level (L_{50}) and level of annoyance (L_{10}) for manual fracturing were 39 dB(A), 65 dB(A) and 105 dB(A) respectively (Table 3).

Table 3: Activity wise weekly average sound pressure levels

Activities	Noise Descriptors	Weekly Average, dB(A)
Boulder Hammering	$L_{Aeq, 8hr}$	92
	L_{max}	103
Manual Fracturing	$L_{Aeq, 8hr}$	99
	L_{max}	111
	L_{95}	39
	L_{50}	65
	L_{10}	105

The calculated noise attenuation in the natural environment from the source followed logarithmic relation with the distance, i.e. R^2 values were greater than 0.923. The average distance attenuation for background sound pressure levels (L_{95}) of the selected three different locations i.e. 50m, 100m and 300m from the noise emitting sources were 60 dB(A), 49 dB(A) and 38 dB(A) and average nominal 8-hour equivalent sound pressure levels ($L_{eq,8hr}$) of these sites were 71 dB(A), 61 dB(A) and 55 dB(A) respectively (Table 4).

Vol. 2, No. 02; 2017

ISSN: 2456-8643

Table 4: Distance attenuation for background and equivalent sound pressure levels

Reference Points	Noise Descriptors, dB(A)	Distance Attenuation, (m)			Remarks
		50	100	300	Reference (300m)
SC 27	L_{95}	52	50	40	$R^2 = 0.983$
SC 05 / 06		63	48	33	
Average		**60**	**49**	**38**	
SC 27	$L_{Aeq, 8hr}$	70	62	58	$R^2 = 0.927$
SC 05 / 06		71	60	43	
Average		**71**	**61**	**55**	

Discussion

The major noise related health effect was tinnitus, which has also been correlated in other studies. Previous studies have shown that the environmental noise could give rise to psychological and psychosomatic symptoms in the form of headaches, fatigue, irritability and annoyance, which is also observed in our study [9, 10].

About nearly half (44%) of the respondents have reported about the after effects of noise disturb sleep. In fact, sleep disturbance is one of the major effect of environmental noise. Exposure to noise can induce disturbance of sleep in terms of difficulty to fall asleep, alteration of sleep pattern of depth and awakenings [11, 12]. After effects of noise – disturbed sleep are reduced perceived sleep quality, increased fatigue, depressed mood or well being and decreased performance [13]. In the literature search on noise induced health effects, very limited information on noise induced psychosomatic symptoms like nausea was found, which the least (10%) health effect was observed in our study.

We found a high odds ratio for the environmental noise induced psychiatric problems among the exposed respondents. This was found despite the low number of cases in our study. Our 95% confidence interval was wide due to the small sample size. A potential limitation of this study is information bias. The main potential source of information bias was reliance on only the place of residence for determining exposure status.

The noise levels were observed to be >85 dB(A) in this study. But, the observed background and equivalent sound pressure levels in three different consecutive distances (50 m, 100 m and 300 m) were found to be within the standard limit. Whereas, the noise level was measured by

Vol. 2, No. 02; 2017

ISSN: 2456-8643

Shrestha and Shrestha [5] and Miyoshi [6] in different industries within and outside the Kathmandu valley and found that noise levels were high in textile industries, metal works, cement industries and flourmills. The highest recorded noise level was 120 dB(A) at Balaju Kapada Udyog.

Therefore, the study shows that noise modifies social behaviours and causes interference to task performance and annoyance to workers. Studies of occupational and environmental noise exposure also suggest an association of noise exposure with physiological health effect, and investigated that the non-auditory effects of noise on health and conclude that effects of occupational and environmental noise on health is strongest for annoyance, sleep and cognitive performance [14].

Conclusion

The purpose of this study was to measure and quantify the noise levels in stone cutting industries and to determine the impacts of noise on workers. Noise pollution problems prevail in stone cutting industries which can interfere to workers performance. The measured noise levels were found to be higher than WHO acceptable limit in all monitoring industries. Workers exposed to noise above 85 dB(A) will eventually developed hearing loss and other health hazards. This suggests that specific intervention is required to protect workers exposure to noise related health effects at workplace. This study recommends that workers in such industries be subject to hearing test and other related illnesses periodically each year. Also, there is a need to educate or regular training those exposed on how best to protect themselves from noise hazards.

References

[1] S.K. Joshi, S. Devkota, S. Chamling and S. Shrestha, “Environmental noise induced hearing loss in Nepal,” Kathmandu University Medical Journal, vol. 1, no. 3, pp. 177-183, 2003.

[2] G.T. Miller, “Living in the environment,” 13th ed., Thomson Asia Pte. Ltd. Singapore, pp. 669-670, 2005, ISBN: 981-265-632-4.

[3] N. Singh and S.C. Davar, “Noise pollution-source, effects and control,” J. Hum. Ecol.,vol., 16, no., 3, pp. 181-187, 2004.

[4] WHO, “Guideline for community noise,” 1999.

[5] C.B. Shrestha and G.B. Shrestha, “A report: survey on noise level in Kathmandu valley,” Kathmandu man and biosphere, pp. 109-114, 1985.

[6] Y. Miyoshi, “Study report on industrial pollution control: Kathmandu industrial series center,” pp. 101-108, 1987.

Vol. 2, No. 02; 2017

ISSN: 2456-8643

[7] CBS, "National population census, household and population by sex, ward level, kaski district, Nepal," pp. 25, 2011.

[8] H. Arkin and R.R. Colton, "Tables for statisticians," 2nd ed., Barnes and Noble, New York, pp. 168, 1963, ISBN: 038-900-120-1.

[9] A. Tarnopolsky, D.J. Hand, S.M. Barker and L.M. Jenkis, "Noise as a public health problem," pp. 588-594, 1980.

[10] I.A. Shrestha, " A dissertation on health effects of vehicular noise pollution on traffic police personnel in Kathmandu," St. Xavier College, Kathmandu, 2001.

[11] J.L. Eberhardt, "Doctoral dissertation: The influence of sleep of noise and vibrations caused by road traffic, University of Lund, 1987.

[12] B. Griefahn, "Cardiac responses caused by shots of tanks during sleep," Journal of Sound and Vibration, vol., 128, pp. 109-119, 1989.

[13] B. Berguland and T. Lindvall, " Community noise," Stockholm: Center for Sensory Research, vol., 5, no. 3, pp. 253-259, 1995.

[14] S.A. Stansfeld and M.P. Matheon, "Noise pollution: non-auditory effects on health," British Medical Bulletin, vol., 68, pp. 243-257, 2003.